

Neural Machine Learning I

COMP / ELEC / STAT 502, Spring 2016

Elective course, 3 credits (3 contact hours per week)

Course home page: <http://www.ece.rice.edu/~erzsebet/ANNcourse.html>

(This website is also linked from Owl Space.)

Students are responsible for being familiar with this syllabus, and with the contents of both the above and the Owl Space website, and follow the postings as the course proceeds.

Class meets: TR 1:00 – 2:15pm DCH 1046

Instructor: [Erzsébet Merényi](#)

email: erzsebet@rice.edu

Office/Phone: DCH 2040, 713-348-3595

Office hour: TBA, and [by appointment](#)

Teaching Assistants and contact information:

TBA

TA advising: by appointment

Short course description

Review of major Artificial Neural Network paradigms. Analytical discussion of supervised and unsupervised learning. Emphasis on state-of-the-art Hebbian (biologically most plausible) learning paradigms and their relation to information theoretical methods. Applications to data analysis such as pattern recognition, clustering (information discovery), classification, non-linear PCA, independent component analysis, with lots of examples from image and signal processing and other areas.

Brief Sample List of Topics

Introduction: What is an Artificial Neural Network (ANN), defining characteristics

Review of Basics: from Calculus, Information Theory and Statistics

Associative Memory recall from partial and noisy samples, stability

Supervised Learning: Simple and Multi-Layer Perceptrons

Evaluation of Learning and Generalization Performance

Unsupervised Learning: Hebbian learning, PCA nets, Competitive Learning (SOMs, LVQs)

Recurrent nets: Hopfield and Boltzmann Machines, Simulated Annealing

Speeding Up Supervised Learning and Structure Optimization

Objective Functions for ANN Learning: information theoretical functions

Identifying Independent Sources (Blind Source Separation) with ANNs

A more detailed sample course outline is posted at

<http://www.ece.rice.edu/~erzsebet/ANNcourse.html/CourseOutline>

Exercises, home works, exam and course project will involve programming in the student's choice of Matlab, C or R (Fortran is also acceptable).

The information contained in the course syllabus, other than the absence policies, may be subject to change with reasonable advance notice as deemed appropriate by the instructor.

Detailed Course Schedule

A detailed schedule of class topics will come on-line in a timely manner at the course web site <http://www.ece.rice.edu/~erzsebet/ANNcourse.html> under [Course Schedule](#) along with reading assignments from text book and lecture notes. I will also indicate here when home work assignments are posted in Owl Space, along with due dates, post the dates of upcoming tests, and all relevant logistics. The materials (such as lecture notes and home work assignments) indicated in the Course Schedule will be downloadable from Owl Space.

Pre-requisites

- No previous knowledge of Artificial Neural Nets is assumed.
- Basic linear algebra (MATH 355, ELEC 302 or equivalent is helpful) and basic calculus (such as in CAAM 322 or MATH 335 or equivalent);
- Basic probability distributions and statistics (such as in ELEC/STAT 331 or equivalent); Basic information theoretical notions (ELEC 241 or equivalent); These will be briefly reviewed in the course.
- ELEC/COMP 440 or ELEC 535 is an advantage.

If you have not taken the above courses, you need to provide evidence that you have the background knowledge and obtain the instructor's consent. Having taken ELEC 430 and ELEC 431 or ELEC 531 and 533 automatically qualifies.

Course Materials

The course will be based on Lecture Notes, scheduled as described at the course web site <http://www.ece.rice.edu/~erzsebet/ANNcourse.html> under [Course Schedule](#) .

Recommended reading will be selected parts of the following books. All are available at www.amazon.com, or at the Fondren Library at Rice. You can also borrow my copies for short periods of times.

On neural networks

- Frederick Ham and Ivica Kostanic: Principles of Neurocomputing for Science & Engineering. McGraw-Hill, 2001.
- Simon Haykin: Neural Networks. A Comprehensive Foundation. McMillan, New Jersey, 1999. (2nd Edition)
- Christopher M. Bishop: Neural Networks for Pattern Recognition. Oxford University Press, 1995.

On machine learning (neural and other)

- Christopher M. Bishop: Pattern Recognition and Machine Learning. Springer, 2007.

Further suggested reading is listed at the course web site under Course Materials.

Objectives of the Course

1. Student understanding of concepts, and mastery, of the main types of neural machine learning models and methods, and their applications to data mining, clustering, classification and regression.
2. Student mastery of both theoretically approaches and using neural network simulations for solving data analysis problems. Understanding and practicing correct methodology

for good neural network learning and generalization, and assessment of the quality of the learning (the generalization capability of trained networks).

3. Student competence in communicating the methods and results of data analyses with neural networks.

Assignments, Grading Policies and Other Logistic Requirements

Grades will be made up of the following components, with approximate weights as shown:

25% - Homework assignments
10% - Quiz 1
10% - Quiz 2
20% - Exam 1
25% - Course Project
10% - Classroom participation

This break down is subject to change depending on resources that will be available to the instructor for grading. Parts of points 1. – 4. below may change accordingly.

1. Homework assignments

There will be approximately four or five homeworks in the first half of the semester. There will be only one or two homeworks in the second half of the semester, in order to allow time for the Course Project. Homeworks and their due dates will also be announced in the [Course Schedule](#) in a timely manner. The assignments themselves will be posted in Owl Space under Assignments, with exact due date / time. You are required to upload an electronic copy (a pdf file) to Owl space. You are not required to type everything but if you have parts produced non-electronically you need to scan your hard copy into a pdf file on a high-quality scanner. If you have problems with electronic upload you can bring a hard copy to class or drop it in the designated wall pocket next to my office door before the deadline, and also notify me of this fact. You will be asked to upload the e-copy once the upload problems are fixed. You are encouraged to work on homeworks in groups but you will hand in your own solution, which you are expected to understand. If the solution is the result of group work, each group member will write the names of the collaborators on their solution. **Solutions from previous years are off-limit.** More details are posted at the course web site under Assignments and Grading Policies. A summary of required formats, file names, and other [logistic requirements are posted here](#) for your convenience. Please be sure to thoroughly read and follow them.

1.1 Late homework policy

Homework is due at the beginning of class on the due date. You will submit solutions electronically through Owl Space. We intend to continue paperless grading that we introduced for this class. (Should any unforeseen problem occur with that, we would need to revert to submitting both an electronic copy, and a hard copy in class.) Should any circumstance prevent electronic submission to Owl Space at any time, please submit a hard copy to me in class or drop it in the designated wall pocket next to my office door, any time before it is due. We will work with your hard copy and ask you to upload the electronic version when the problem has been fixed. However, please let me and the TA(s) know immediately (by phone if necessary) of any problem accessing Owl Space. After the due date, but before the due date of late homework (the "accept until" date in Owl Space), homework can be turned in for 50% credit. After the late due date submissions will not be

allowed in Owl Space, and homework submitted in any other way after the late due date will receive 0% credit.

2. Tests

There will be three tests. Quiz 1 and Quiz 2 (approx. 40 - 45 min, in class, closed notes/books/phones/computers), and a midterm exam. The exact dates of these will be posted in the [Course Schedule](#) in a timely manner, as well as announced in class. The anticipated dates are early - mid February (Quiz 1), early March (Midterm), and late March or early April (Quiz 2). The Exam will be open book and open notes but using restricted time, and other resources (such as internet) will be restricted, and you will be required to write and sign the honor pledge. The exact requirements and details will be given with the exams. **Test solutions from previous years are strictly off-limit.**

3. Course Project

A Project will be done over an approximately four-week period in the second half of the semester. Students will form groups of 1 to 4 by self-organization :-). Each group will submit a project proposal on approximately March 10 (exact date TBD, and as will be posted in the [Course Schedule](#)). It is anticipated that by that time the major ANN paradigms will have been discussed in class and students will be able to select a project topic, either from a list provided by me, or devise their own. I will review and approve each proposal (or discuss necessary modifications) before students start executing plans. [Details, requirements and the characteristics of a successful Project are described here.](#)

4. Class Participation You will be expected to keep up with the material we review in class and answer questions in class. Asking relevant questions or participating in discussions will also earn you scores.

Missed assignments If you must miss (or be late with) a homework, or a test due to an extraordinary circumstance please notify me and the TA(s) as much ahead of time as possible, and **make arrangements with me** for completing the missed assignment. If, in extreme emergency, you are unable to provide advance notice, please let me know as soon as possible afterwards, and I will work with you on a solution accordingly.

Expectations Regarding Honor Code, Collaboration, and Citation

In preparing home works, students are encouraged to work in groups and consult freely any material and anyone. However, each individual will write and turn in his or her own solution, which they are expected to understand. If the solution is the result of group work, each group member will write the names of the collaborators on their solution. For tests students will be required to state and sign the Rice Honor Pledge and adhere to the Rice Honor Code. Solutions from previous years are off-limit. In all work, students are expected to be scrupulous about proper citation of sources (where applicable), as required both as a matter of integrity and formally as a part of the Rice Honor Code.

Class Attendance and Absence Policy

Students are strongly advised to attend all classes. 10% of the grade is composed of participation and performance in class. Students who must miss a class or assignment because of unavoidable circumstances should consult with the instructor well in advance so that alternative arrangements may be made.

University Disability Accommodation Policy

The University seeks to foster an environment of broad access and feasibly equal opportunity to education. The Office of Disability Support Services (DSS; Allen Center, Room 111; 713-348-584; adarice@rice.edu) supports and implements federal guidelines under the Rehabilitation Act of 1973 and the Americans with Disabilities Act. Students with documented disabilities requiring accommodation under Rice's established policies should consult DSS and the instructor; all such consultations and accommodations will be held confidential to the extent feasible.

Use of Machines in the Classroom

Cell phones must be turned off – or rendered silent – within the classroom. If you need to take an urgent call, please set your phone to vibration and take the call outside the room. Laptops or other small devices may be used in class only for specific class purposes. If you have an urgent need to be online for other purposes during class time, feel free to do so . . . but elsewhere.